

POLICY BRIEF

# **BUILDING A RESILIENT FUTURE FOR THE TOCUMEN AREA OF THE PANAMA BAY WETLANDS: RECOMMENDATIONS FOR LAND USE PLANNING AND MANAGEMENT**

Based on Rapid Ecological Assessment by Wetlands  
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# INTRODUCTION

The wetlands on Panama Bay immediately east of Panama City provide innumerable benefits to local communities and serve as a natural buffer against flooding and coastal erosion. These ecosystems are also a refuge for biological diversity, furnishing a home for coastal and marine life including migratory birds.

Over the past several decades, unplanned development has led to the destruction and fragmentation of wetland habitats. Pollution has altered water quality, negatively affecting the health of river systems, mangroves, and the many species that depend on them. This has led to increased vulnerability to flooding as watercourses are altered and sensitive areas are occupied. Climate change is expected to exacerbate extreme-weather events such as storms and tidal surges, causing greater coastal erosion and loss of critical habitats.

The good news is that solutions are available to restore the vitality of these essential wetlands and re-establish their ability to provide the ecosystem services that humans depend on. Based on ecological assessments of the area's mangrove forests and river basins, and other research, this analysis underscores the critical need for a coordinated strategy to manage urban development and safeguard these wetland environments. It is essential that national and local leaders act now to ensure the long-term resilience of coastal ecosystems and the prosperity of communities that depend on them.



# METHODOLOGY

The findings and recommendations detailed in this policy brief are based on research that includes a rapid ecological assessment of the wetlands between the Costa del Este area and Pacora River, and a compilation of past expert studies and their specific recommendations for the overall Juan Díaz watershed. One assessment focused on this 351 km<sup>2</sup> watershed, where urbanized areas have grown more than sixfold since 1960. While other assessments analyzed the condition of mangroves and associated ecosystems in the lower Juan Díaz basin, with special attention to those in the Tocumen sub-watershed.

The rapid ecological assessment is a cost-effective method to identify threats and determine recommendations needed to guide conservation efforts, using a variety of remote sensing and field techniques. It evaluates a region's biodiversity and ecosystem health and the various benefits nature provides to people. Based on this assessment and other research, a series of recommendations were developed to guide the protection and restoration of these ecosystems, benefit biodiversity and make coastal communities and marine ecosystems more resilient.



# THREATS TO THE TOCUMEN AREA'S WETLANDS

## Natural Resource Extraction

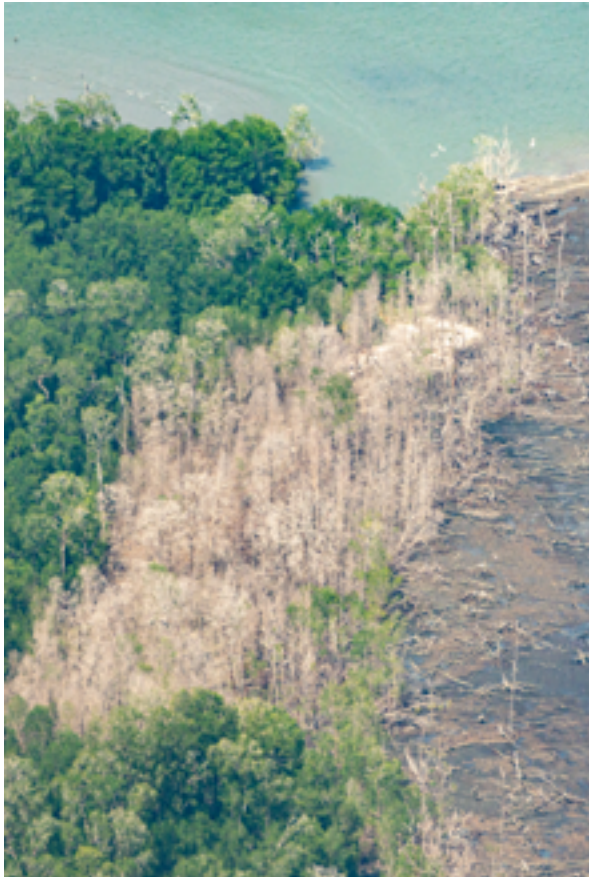
- Illegal mangrove logging and overfishing have had a negative impact on species and their habitats.
- Mangrove loss reduces spawning areas for fish as well as nesting and resting areas for birds.
- Overexploitation of crustaceans and bivalves has reduced their populations, threatening ecosystems as well as residents' livelihoods and food security. Water pollution can create health risks for people consuming seafood in contaminated areas.



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## Climate Change

- The Tocumen area and much of Panama City's coast are vulnerable to increased flooding due to sea level rise and more powerful storms.
- By 2050, regions around the Juan Díaz River basin are projected to experience significant flooding, with approximately 15,000 hectares and key infrastructure at risk.
- Sea level rise and extreme weather events threaten mangroves' ability to withstand storms and will exacerbate problems with sewage and pollutants in river channels.



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## Urbanization and Coastal Development

- Roads, housing, and other infrastructure have caused extensive wetland loss and reduced mangrove cover by an estimated 68 percent since 1980.
- Habitat degradation has diminished the ability of mangroves to function as natural flood barriers, making coastal areas more vulnerable to extreme weather events.
- Population growth in the study area — from 614,284 in 2010 to 834,283 in 2023, and projected to reach nearly 1.4 million by 2050 — has affected species populations by decreasing wildlife habitats.
- Expansions of Tocumen International Airport have converted large swathes of agricultural land and natural areas into urbanized areas. Proposed expansions and other development would likely exacerbate wetland degradation.



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## Watershed Pollution and Interventions

- Sewage, agricultural runoff, and industrial waste are degrading coastal water quality, harming marine and terrestrial life, and can affect human health.
- Since the 1960s, interventions such as river channeling and diversion have altered the flow and capacity of the Tapia, Tocumen, and Juan Díaz river systems, raising flood risks and transforming the natural landscape.
- The construction of Tocumen's Terminal 2 diverted water away from rivers and into infrastructure such as the Southern Corridor highway.
- Deforestation and occupation of natural channels have further obstructed water flow, complicating flood management and exacerbating flood risks.
- Due to inadequate collection and unregulated disposal, much of the garbage produced in the Juan Díaz and Pacora river basins ends up in mangrove forests, affecting the area's fauna.



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# RECOMMENDATIONS

## Proposed Prevention and Mitigation Measures

Collaborative action focused on protecting and restoring wetland ecosystems will benefit biodiversity and make coastal communities and marine ecosystems more resilient.



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These recommendations for conservation and sustainable management can decrease risks and ensure a balance between human development and biodiversity protection.



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### Urban and Territorial Planning

To make urban growth more sustainable, existing urban land-management systems need to be aligned with principles that promote long-term environmental responsibility. To achieve these goals, updated flood maps, comprehensive zoning codes, and enhanced citizen engagement in urban planning are essential.

- Conservation and sustainable use: Protect and restore natural resources—water, soil, air, ecosystems—within the metropolitan region.
- Compact urban development: Promote concentrated growth zones supported by public transit and avoid sprawl.
- Flood-prone area restrictions: Limit construction in vulnerable zones, minimizing risks from floods, landslides, and climate change impacts.

### Disaster risk and climate change

Panama’s National Policy on Disaster Risk Management (2022–2030) highlights unplanned urban expansion as a risk factor for disasters. Flood control proposals from past studies should be reviewed to integrate sustainable solutions like natural river channels, reservoirs, and geomorphological approaches.

- Enhanced interagency coordination: Link climate change strategies with disaster management and local planning instruments for cohesive policy action.
- Resilient urban planning: Implement and enforce zoning restrictions and support sustainable, safe development that considers vulnerability assessments.
- Early warning systems: Establish systems in critical flood-prone areas within the Juan Díaz basin, ensuring timely alerts to protect lives.



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### Forest Management

Science-based forest conservation and reforestation can protect nearby residents from flooding and protect biodiversity and livelihoods of coastal communities that rely on mangrove ecosystems for food, income, and materials. Strengthening mangrove and forest protections, based on Panama’s Forestry Law and Wetlands Policy, is critical.

- Ban deforestation in protected wetlands: Maintain mangrove integrity, especially in vulnerable areas throughout the Juan Díaz basin.
- Mangrove ecological restoration: Restore hydrological conditions, construct permeable dams, and clean tidal channels to maintain water flow and reduce flood risks, allowing for natural regeneration of mangroves. As a last resort, carry out reforestation of mangrove native species in degraded areas to support recovery.
- Climate resilience studies: Evaluate impacts of sea level rise on mangroves, developing strategies to safeguard these vital ecosystems by anticipating potential changes in coverage.



Angelo Gutiérrez

### Flood Risk Management

Infrastructure in at-risk areas should meet stricter codes, and flood scenarios should inform the Airport Master Plan and other critical projects. Accurate and current data is crucial for understanding flood risks.

- Flood mapping updates: Develop new cartography to update digital terrain models and digital surface models for precise flood projections.
- Probabilistic flood studies: Forecast probable flood areas based on rainfall and sea level rise, integrating historic data on wetlands and mangrove areas in the Juan Díaz basin.
- Community access to data: Publicize findings to support decision-making across government, civil society, and private sector.





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### Education, Awareness, and Regulation

Changing destructive patterns of human activities in the area will be crucial to efforts to balance economic growth with environmental preservation, prioritizing the safety and well-being of the population.

- Promote public awareness of the importance of mangroves and associated ecosystems, and the need for their conservation. This may include educational programs in schools, community awareness-raising activities, and campaigns that encourage informed decision-making based on sound science.
- Establish and/or enforce conservation areas and buffer zones around mangroves to limit development and resource extraction. These areas must have clear regulations that prohibit destructive activities and guide smarter development.
- Establish and enforce sustainable management practices for activities such as fishing and shellfish harvesting.



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### Disaster Risk Management and Climate Change Adaptation

Inclusion of sustainable solutions like natural river channels, reservoirs, and geomorphological approaches in management and policies can reduce disaster risks and support adaptation.

- Enhanced interagency coordination: Link climate change strategies with disaster management for cohesive policy action.
- Resilient urban planning: Implement and enforce zoning restrictions and support sustainable, safe development that considers vulnerability assessments.
- Early warning systems: Develop systems as part of an integrated framework of disaster risk reduction, climate change adaptation and ecosystem management and restoration.
- Resilient coastal ecosystems: Help mangrove ecosystems adapt to sea level rise through a combination of measures including use of nature-based solutions, restoration supported by climate change information, and facilitating their inland migration through the establishment of buffer areas.



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### Environmental Monitoring and Evaluation

Environmental monitoring is needed to evaluate water quality and flow, mangrove health, and biodiversity. Baseline surveys and follow-up monitoring of ecosystem health will enable early detection of both risks and emerging issues.

- Habitat classification and comparison: Conduct studies to classify habitats within Panama Bay and develop similarity and comparative indices to assess changes in biodiversity and mangrove health over time.
- International cooperation: Collaborate with international organizations and other nations to share knowledge and resources regarding mangrove conservation and coastal management.
- Periodic evaluation: Conduct periodic assessment of different plans' progress and adjust strategies as necessary.
- Evaluation of exotic species: Carry out a detailed evaluation of exotic species present in the area to determine their impact on native species and ecosystems.



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### Public Spaces and Citizen Involvement

Public spaces and citizen involvement can enhance community connection to ecosystems, while creating sustainable communities and a healthier environment for future generations.

- Eco-parks and recreational spaces: Develop riverside parks and green spaces in wetlands and mangrove areas for community enjoyment and environmental education.
- Replicate successful models: Draw inspiration from successful projects such as Thailand's Green Bangkok 2030, integrating public access with flood mitigation efforts.
- Citizen involvement in project development: Ensure community participation in planning urban natural parks near mangroves, like Colombia's Ciénaga de Mallorquín Ecopark, which incorporates educational and recreational facilities to promote eco-friendly activities such as bird-watching and nature walks.



# A Time-Limited Opportunity to Protect a Vital National Resource: Flood Solutions

Panama Bay urgently needs a management plan to provide a clear road map to conserve the bay, its essential ecosystem services, and the wildlife that use it year-round. Such a plan would include financial, governance, and sustainability components and incorporate mechanisms to adapt to climate change. The creation of this plan should be an urgent priority for governments, local communities, NGOs, and private-sector stakeholders.

**Area Delimitation, Features and Measures**

- Road network
- Rivers and ravines
- Proposed channeling
- Nature-based measures
- Channeling, dredging
- Reservoir
- Banks + channeling
- Juan Díaz River basin
- Humedal Bahía de Panamá Wildlife Refuge
- District delimitation
- Urban footprint 2020
- Flood-affected neighborhoods
- Flood footpring t500
- Sea level rise to 2025 (ssp585)



# What are the consequences if we fail to protect the Tocumen area’s wetlands?

Without timely action to protect this essential natural resource, we can expect...



1

Increased threats to coastal communities and critical infrastructure from rising sea levels and increasingly powerful storms which bring about flooding events and coastal erosion.



2

A further imbalance between the protection of human life and nature and the preservation of infrastructure which hinders long-term resilience of the overall area.



3

Continued deterioration of water quality, exacerbating problems with sewage and pollutants in river channels and threatening the health of humans, fauna and flora.



5

Loss of habitat for birds and other wildlife. Slow onset climate change combined with other anthropogenic effects and deficient land-use planning restricts habitat and ecosystem resilience.



4

Loss of fish production. Mangroves and other wetland ecosystems serve as essential habitats and food sources for commercially valuable fish and invertebrates, supporting artisanal fish harvesting that will continue to decline under the current scenario.



6

Loss of carbon sequestration capacity and its benefits. Over the next century, mangroves in Panama Bay could sequester an estimated 20.1 million tons of carbon dioxide equivalent, with an economic benefit of approximately \$116 million annually (using the social cost of carbon).



## CONCLUSION

The peri-urban wetlands of the Tocumen area are a vital resource for coastal communities, shielding them from storms, buffering sea-level rise, and purifying air and water. These ecosystems also support diverse wildlife and capture carbon, helping to fight climate change.

Rapid population growth and unchecked infrastructure have weakened these natural defenses, increasing the region's vulnerability to floods and other hazards. There is still time to preserve these ecosystems for future generations. Coordinated conservation and restoration efforts can enhance biodiversity and strengthen coastal communities and marine environments. A sustainable management plan, harmonized with disaster risk and land use planning instruments, is urgently needed to guide conservation, reduce risks, and create a balanced future between development and nature.

These actions must be a priority for governments, communities, NGOs, and the private sector. With a united approach, we can build a resilient and sustainable future for the Tocumen area's wetlands.



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Roadside Hawk in Bay of Panama wetlands.



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